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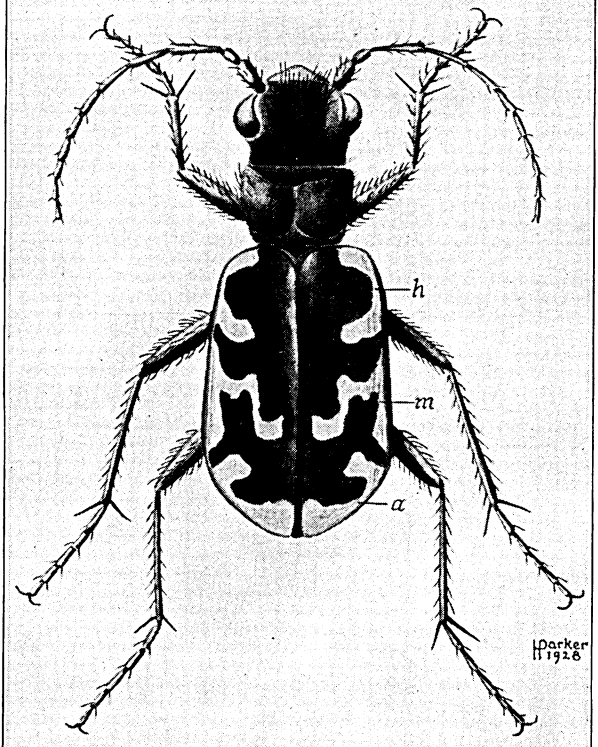
TIGER BEETLE
(Cicindela repanda)



h - humeral lunule
m - median band
a - apical lunule

BIOLOGY OF THE TIGER BEETLES WITH A KEY TO THE SPECIES OF CICINDELA FOUND IN MINNESOTA

R. W. DAWSON

Few groups of insects, aside from the butterflies, have proved so interesting and attractive to amateur students as the tiger beetles. This is particularly true of the type genus, *Cicindela,* which is the dominant or major one in the family. This brief review of the tiger beetles of Minnesota is offered in the hope that it may afford one of the early stepping stones for the development of an interest in the study of insects.

The beginner, as well as the advanced student, finds the tiger beetles an attractive group for several reasons. They are neatly marked and beautifully, even gorgeously, colored. Their beauty, along with the ease and certainty with which specimens may be preserved in perfect condition, renders them more than usually satisfactory material for the building of a collection.

The variety of forms is relatively large. Seventy-six species and 102 varieties are at present cataloged for the United States and Canada. The recognition and correct separation of all these forms constitutes a challenge to the student, and herein lies the first absorbing interest in the tiger beetles. The pursuit of this taxonomic interest tends strongly to lead one into some of the great modern problems of biology, namely, ecology, genetics, and evolution, for only by the aid of these fundamental fields of study can one hope to settle the more difficult and obscure questions in classification.

The frontispiece illustrates the generalized, or type, pattern of markings characteristic of the North American tiger beetles. The "idea" of this color pattern runs through the whole genus. The color design of all the species may be derived from this pattern by relatively simple modifications of its parts. These parts, as the plate shows, consist of the humeral lunule, median band, apical lunule, and marginal band. These elements show a homology almost as precise and definite as do the bones of a series of vertebrate animals. The evidence from homologies is one of the great categories of facts supporting the theory of evolution. That even such a superficial character as color markings should show definite homologies is a remarkable and interesting fact. To illustrate it the plate showing the elytra of the various local forms has been arranged as a graded series to show how the modifications may progress. The real relationships of the species and varieties are not shown by this character alone, and the plate, therefore, does not

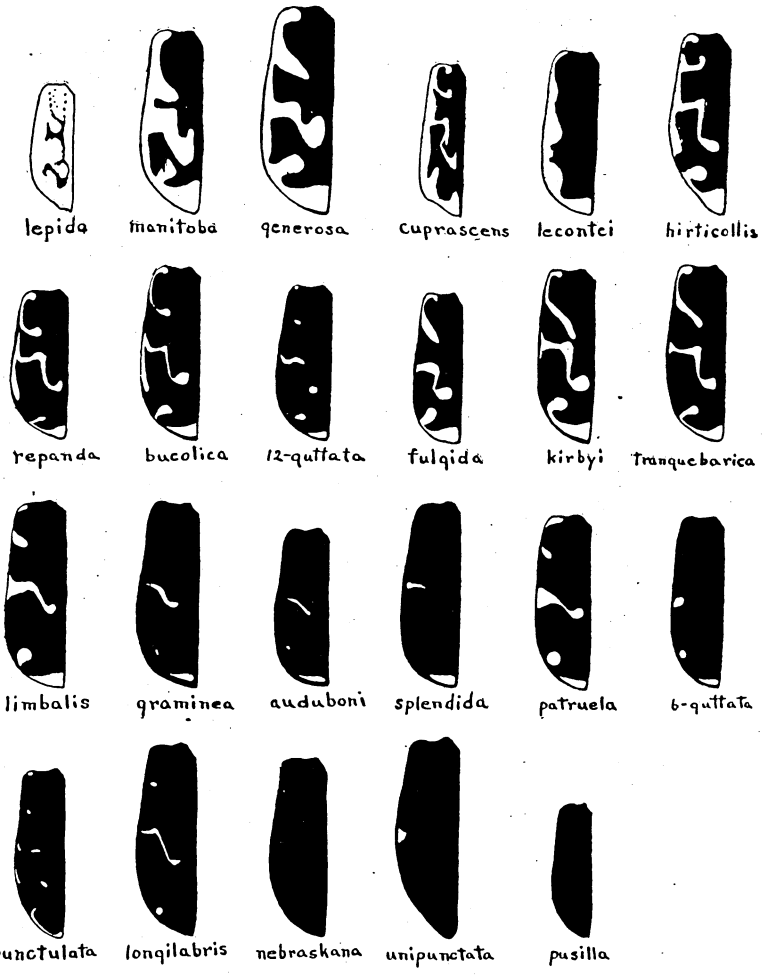
reflect an evolutionary series, but shows the homologies of the color patterns, and aids in making identifications.

In the days of Linnaeus, the first great classifier of plants and animals, the universally accepted idea was that species were separately or "specially" created, each distinct, fixed, and unchanging. Echoes of this idea still persist. It becomes, then, an item of peculiar interest that no group of common animals gives more striking and absorbingly interesting evidence bearing upon this question of the fixity of species than does the group of tiger beetles. Nearly every species has a valid, named variety, and sometimes several of them. Many of the varieties show every step of gradation in the transition from the one to the other; and when some of the complete transitional series are assembled one is amazed at their range and at the definiteness with which the variations are correlated with seasons, habitats, and geographical distribution.

The student of ecology may find much of interest in the tiger beetles. The plastic nature of their colors and markings renders them peculiarly appropriate material for the study of variations induced by climatic and physical factors—temperature, moisture, light, soil types, and others. In a general way, higher temperatures tend to reduce the strength (area) of the pale markings of the elytra, and lower temperatures tend to augment the pale markings. Similarly, brilliance of color is suppressed by moisture and brought to full expression by dryness, The segregation of the various species and varieties to particular soil types and moisture conditions is rather definite.

Life histories and habits constitute another phase of the ecological aspect of the study. The species are all predacious, and are so active and aggressive in character as to well deserve the name "tiger" beetle. Any small creature, caterpillar, fly, ant, or even spider, is appropriate prey. The prey is fiercely pounced upon and devoured with avidity. The beetles are very nimble and agile, they run and hide with great facility and take wing upon slight provocation.

The larvae, also, are predacious. They occur in the same local habitats as the adult beetles—clay banks, sand pits, sandy beaches of lakes and streams, roads, woodland paths, and bare spots of ground. For the most part they dig essentially perpendicular burrows in which to live, and secure their prey by resting at the top of the burrow. The flattened top of the head and front segment of the thorax nearly fill and close the mouth of the burrow. The unsuspecting insect pedestrian is suddenly seized by the large, powerful jaws and dragged into the burrow to be devoured. The tiger beetle larva is protected by the armor on top of the flattened head and prothorax, and the victim is at a complete disadvantage. The remainder of the larva's body, which is protected by the walls of the burrow, is soft and delicate.


lepida
manitoba
generosa
cuprascens
lecontei
hirticollis
repanda
bucolica
12-guttata
fulgida
kirbyi
Tranquebarica
limbalis
graminea
auduboni
splendida
patruela
6-guttata
punctulata
longilabris
nebraskana
unipunctata
pusilla

A pair of dorsal prominences, or hooks, enables the larva more readily to maintain its strategic position at the top of the burrow. An interesting demonstration of these larvae and their burrows may often be had where they are common by standing quietly for a few minutes, then suddenly stamping upon the ground, or moving the arm so as to cast a wave of shadow across the bare ground. The sudden dropping of all the tiger beetle larvae from the mouths of their burrows seems magically to perforate the ground with numbers of sharply outlined round holes. After a few moments of quiet the holes unobtrusively disappear as they are "plugged" one after another by the heads of the occupants.

The life cycle of *Cicindela purpurea* has been summarized by Shelford (5), at Chicago, as follows: Eggs are laid in May; larvae reach the last (third) stage in August, hibernate, begin to feed again in April, and pupate in July. The adults emerge in August, feed for a time, hibernate, and come out in the second spring, reach sexual maturity in the first warm days of April, and soon begin depositing eggs. Upon the completion of this function they die. The larval life thus lasts from 12 to 13 months and the adult life 10 months. This makes a two-year life cycle. Criddle (1), at Aweme, Manitoba, finds that two years are required there for the larval development, and that therefore three years are required for the life cycle. As the broods overlap, specimens are to be seen in essentially equal numbers every year. One of our common species, *C. punctulata,* apparently has an annual cycle in the region of Chicago.

The depth of the burrows of tiger beetles and their larvae varies greatly, from a few inches to 6½ feet, depending upon the species, temperature, moisture, and type of soil. The deep burrows are for winter hibernation (recorded by Criddle, in Manitoba).

Something of the interest that has long attached to this group of insects may be gleaned from the following quotation from Dow (2). "When the news reached London that Say had caught a tiger beetle an inch and one-half long, of a new genus, an enthusiast bid $300 gold for the specimen, and Say accepted it. Both sides were quite satisfied, for as luck would have it, a second specimen was not captured until about twenty years later." Again: The beautiful species *C. limbata* was lost to science for a number of years after Say described it. When rediscovered, specimens were so much in demand by collectors and students that several collecting expeditions were financed by the sale of specimens, until the world market was supplied. The "golden days" are past. There is no money in tiger beetles, but these incidents help one to realize the interest that has long centered upon these attractive insects.

KEY TO THE SPECIES OF MINNESOTA TIGER BEETLES

1. Front entirely bare (except for the few erect orbital bristles that are present in all species) 2
   Front clothed (at least sparsely) with hairs 8
2. Color brilliant green, blue, purple, or changeable green to blue and purple 3
   Color black, dull black, or at most with a bronzed or purplish sheen 4
3. Immaculate or with traces of normal markings in the form of three white dots on each elytron.....*sexguttata* Fabricus
   Strongly marked, humeral and apical lunules interrupted at the middle but median band complete ..... *sexguttata* subsp. *patruela* Dejean
4. Front with a well-marked depression or dent between the eyes; depression limited below by a distinct transverse elevation 5
   Front without a well-marked depression or dent between the eyes 6
5. Surface luster duller, color brownish black; normal markings more or less well indicated .....*longilabris* Say
   Surface shining black; pale markings suppressed ..... *longilabris* var. *nebraskana* Casey
6. Sides of thorax and abdomen beneath thinly clothed with pale hairs 7
   Sides of thorax and abdomen beneath bare; body above flatter than usual; color opaque black, showing a marked violet sheen under a hand lens; elytra with a mid-lateral pale spot ....*unipunctata* Fabricius
7. Elytra with a row of large, metallic foveae or pits near the suture, and a short double row of the same near the humeral angles. Color blackish above with more or less evident blue, green, or purple reflections, and traces of normal pale markings; length 10-13 mm. ..... *punctulata* Oliv.
   Elytra without large, metallic foveae; color usually dull black with or without pale markings; size small, length about 10 mm. .....*pusilla* Say
8. Antennae and legs pale testaceous; creamy white markings of elytra very broad, partially confluent, so that the prevailing color of the elytra is creamy white .....*lepida* Dejean
   Antennae and legs dark, or brilliantly metallic; creamy white markings of elytra absent to very strong and bold, but never dominating the general color tone of the insect 9
9. Front, middle, and almost always hind trochanters, and sometmies tibiae also, testaceous 10
   Legs without any testaceous coloring, entirely bright metallic like body ... 11
10. Elytra brilliant cupreous, strongly and densely punctured, pale markings very distinct .....*cuprascens* Leconte
    Elytra less brilliant, bronzed rather than cupreous, less strongly punctured, markings narrower and less distinct ..... *cuprascens* var. *macra* Leconte
11. Pale markings of elytra confined to an irregular submarginal band, often more or less interrupted, and evidently formed by the coalescence of the lateral portions of the typical pale markings; color varying, dull cupreous to bronzed ...*scutellaris* subsp. *lecontei* Hald.
    Pale markings of elytra not confined to the sides in the form of an irregular band 12
12. General color above red, green, or black 13
    General color above dull brown, bronzed brown, or blackish brown; pale markings usually complete, or typical 17

13. Smaller, slenderer species, length 11-12 mm.; color above in different individuals varying from a very brilliant light red to a deep blackish red, surface polished or shining ..... *fulgida* Say

Larger, more robust species; length 13-15 mm.; surface less polished and less shining 14

14. Head and pronotum brilliant green, blue, or purple in marked contrast to the red elytra; pale markings much reduced .... *purpurea* subsp. *splendida* Hentz

Head and pronotum not colored in marked contrast to the elytra 15

15. Color uniformly black, except for traces of the typical pale markings..... *purpurea* var. *auduboni* Leconte

Color red or green, head and pronotum with coppery reflections 16

16. Green above, lateral margins of elytra with coppery reflections; median pale bland oblique and well marked ..... *purpurea* var. *graminea* Schpp.

Red above; margins of elytra green or blue with traces of coppery reflections; pattern of pale markings often nearly complete ..... *purpurea* subsp. *limbalis* Klug.

17. Posterior third of humeral lunule bent abruptly inward and directed slightly forward; elytra with sides more bulging than usual and their apex more distinctly produced ..... *hirticollis* Say

Posterior third of humeral lunule bent obliquely inward, never so abruptly as to be directed anteriorly 18

18. Smaller species, length 11-13 mm. 19

Larger species, length 13-19 mm. 21

19. Markings slenderer, usually broken into dots, middle band usually not at all extended on the lateral margin ..... *duodecimguttata* Dejean

Markings broader, usually not interrupted; median band more or less extended along the lateral margins of the elytra 20

20. Color dark brown; form relatively broader and shorter; pronotum relatively narrower in proportion to the width of the head; pale markings stronger, middle band more extended on the margin, approaching or even uniting with the humeral lunule ..... *duodecimguttata* subsp. *repanda* Dejean

Color blackish brown; form relatively more elongate; pronotum broader in proportion to the width of the head; pale markings narrower, the median band less extended on the elytral margin, and not closely approaching the humeral lunule ..... *duodecimguttata* var. *bucolica* Casey

21. Pale markings bold and heavy, broadly connected on the elytral margins 23

Pale markings not connected laterally 22

22. Bright bronze, thorax cupreous, lunule entire ..... *tranquebarica* subsp. *horiconensis* Leng

Dull bronze, markings heavy, humeral lunule very long, almost touching the median band ..... *tranquebarica* subsp. *kirbyi* Leconte

Darker, more blackish brown, markings narrower, humeral lunule shorter *tranquebarica* Hbst.

23. Elytral markings exceptionally strong and bold; pale hairs somewhat more densely placed and more conspicuous .... *formosa* race *manitoba* Leng

Elytral markings less strongly developed; pale hairs less dense and conspicuous ..... *formosa* subsp. *generosa* Dejean

NOTES AND RECORDS ON THE TIGER BEETLES OF MINNESOTA

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The Division of Entomology and Economic Zoology, University of Minnesota, was kind enough to send me for study the material of the Cicindelidae of the world belonging to their insect collection. As the fauna of Minnesota is especially well represented in this lot, I give herewith a list of them. I have added some species not represented in the material sent to me, but known to me as occurring in Minnesota.

1. *Cicindela formosa* subsp. *generosa* Dejean

Localities represented: Anoka County, Fridley sand dunes, June 1, 1922 (Wm. E. Hoffmann); Anoka County, Fridley sand dunes, July 14, 1922 (A. A. Nichol); Anoka County, Fridley sand dunes, August 8, 1922 (C. Johnson); Hennepin County, May 24, 1920 (Wm. C. Cook); Ramsey County, New Brighton, June 30, 1922 (C. E. Mickel); Ramsey County, July 13, 1910; Scott County, Barden sand dunes, July 29, 1923 (R. W. Dawson); Scott County, dunes near Jordan, August 1 (Wm. E. Hoffmann); Scott County, sand dunes, August 25, 1922 (A. A. Nichol); Washington County, August 13.

2. *Cicindela formosa* race *manitoba* Leng

The following specimens are intermediate in form, more or less related to the Canadian race "*manitoba* Leng:"

Localities represented: Anoka County, Fridley sand dunes, August 8, 1922 (C. Johnson); Scott County, Barden sand dunes, August 25, 1922 (C. E. Mickel); Scott County, Jordan sand area, July 23, 1923 (H. H. Knight); Ramsey County; Scott County, Barden sand dunes, July 29, 1923 (R. W. Dawson).

3. *Cicindela purpurea* Olivier

Localities represented: Clearwater County, Itasca Park, August 15-30, 1921 (H. L. Person); Clearwater County, Lake Itasca, May 27, 1911; Clearwater County, Lake Itasca, June, 1911; Ottertail County, May 24; Ramsey County, St. Anthony Park, St. Paul, May 10, 1909; St. Louis County, Tower.

4. *Cicindela purpurea* var. *auduboni* Leconte

The black form, *auduboni* Leconte 1856 (!) = *spreta* Leconte 1856 (!) is represented by one specimen from Ramsey County.

5. *Cicindela purpurea* var. *graminea* Schpp.

The greenish form, *auduboni* Leconte 1845 (!) = *graminea* Schpp. 1883/4 is represented by one specimen from Ramsey County, 1917.

6. *Cicindela purpurea* subsp. *splendida* Hentz

This species is known to me from an unrecorded locality in the state of Minnesota.

7. *Cicindela purpurea* subsp. *limbalis* Klug.

Localities represented: St. Louis County, Duluth; Clearwater County, Itasca Park, June 12, 1914; Itasca County; Clearwater County, Itasca Park, August 15-30, 1921 (H. L. Person); Norman County, March 30; Ottertail County.

8. *Cicindela duodecimguttata* Dejean

Localities represented: Renville County, Bird Island, August 25, 1921 (Wm. E. Hoffmann); Clearwater County, Itasca Park, August 15-30 (H. L. Person); St. Louis County, August 13, 1910.

9. *Cicindela duodecimguttata* var. *bucolica* Casey

In this variety the single lunules are not interrupted (*bucolica* Casey = *edmontonensis* Carr.).

Localities represented: Anoka County, June 5, 1920; Lake County, Baptism Creek, August 21, 1920 (H. H. Knight); Lake County, Bengal, August 18, 1922 (H. H. Knight); Big Stone County, July 20, 1911; Renville County, Bird Island, August 25, 1921 (Wm. E. Hoffmann); Cook County, Cascade River, August 14 (H. H. Knight); Hennepin County, Crystal Lake, July 30, 1921 (A. T. Hertig and H. H. Knight); Rice County, Faribault, June 20, 1922 (Wm. E. Hoffmann); Hennepin County, July 6, 1910; Hubbard County, N. E. corner Itasca Park, August 22, 1922 (Wm. E. Hoffmann); Clearwater County, Itasca Park, July 1-13, and August 4-30, 1921 (H. L. Person); Lesueur County, Fish Hatchery, July 22, 1923 (Sam Kepperley); Lesueur County, July 25, 1922 (R. R. Holland); Nicollet County, September 7, 1923 (Wm. E. Hoffmann); St. Louis County, August 27, 1910; Nicollet County, St. Peter, Fish Hatchery, August 11, 1923 (Sam Kepperley); Chisago County, Taylors Falls, August 5, 1922 (H. H. Knight); Wilkin County, August 14, 1912.

10. *Cicindela duodecimguttata* subsp. *repanda* Dejean

Localities represented: Anoka County, August 9, 1920 (H. H. Knight); Beltrami County, August 9, 1910; Renville County, Bird Island, August 25, 1921 (Wm. E. Hoffmann); Hennepin County, Crystal Lake, July 30, 1921 (A. T. Hertig); Hennepin County, April 22, June 10, and July 6; Hennepin County, Lake Independence, July 30, 1918; Hennepin County, May 24, 1920 (Wm. C. Cook); Houston County, June 15, 1910; Clearwater County, Itasca Park, July 1-13, and August 15-30, 1921 (H. L. Person); Washington County, Newport, July 18, 1922 (C. E. Mickel); Steele County, Owatonna, Straight River, June 22, 1922 (Wm. E. Hoffmann); Ramsey County; Ramsey County, Battle Creek, May 20, 1922 (C. E. Mickel); Ramsey County, June 25, 1921 (H. H. Knight); Sibley County, river near Blakeley, July

17, 1922 (Wm. E. Hoffmann); Ramsey County, St. Anthony Park, St. Paul, April 20; Nicollet County, St. Peter, July 20, 1922 (A. T. Hertig); Nicollet County, St. Peter, near Fish Hatchery, August 11, 1923 (Sam Kepperley).

11. *Cicindela hirticollis* Say

Localities represented: Ramsey County, Gray Cloud Island, July 12, 1921 (Wm. E. Hoffmann).

12. *Cicindela tranquebarica* Hbst. = *vulgaris* Say

Localities represented: Scott County, Barden sand dunes, August 25, 1925 (C. E. Mickel); Renville County, Bird Island, August 25, 1921 (Wm. E. Hoffmann); Clearwater County, Itasca Park, August 15-30, 1921 (H. L. Person); Clearwater County, Lake Itasca, May 25, June 3, 1914 (on sand heap, running), June 21, and August 12; Ottertail County, May 24; Cass County, Pillager, September 14, 1918 (V. R. Haber); Ramsey County, Gray Cloud Island, July 12, 1921 (Wm. E. Hoffmann); Scott County, sand dunes, August 25, 1922 (A. A. Nichol); Scott County, Shakopee, June 10, 1922 (C. E. Mickel); St. Louis County, Tower.

13. *Cicindela tranquebarica* subsp. *kirbyi* Leconte

The following specimens are intermediate in form, the middle band is enlarged near the lateral border (more or less resembles subsp. *kirbyi* Leconte).

Localities represented: Clearwater County, Itasca Park, August 15-30, 1921 (H. L. Person); Clearwater County, Lake Itasca, May 1; Ottertail County, August 21; Scott County, sand dunes, August 25, 1922 (A. A. Nichol).

14. *Cicindela tranquebarica* subsp. *horiconensis* Leconte

This subspecies is known to me from an unrecorded locality in the state of Minnesota.

15. *Cicindela longilabris* Say

Localities represented: Lake County, Baptism Creek, August 21, 1920 (H. H. Knight); Lake County, Bengal, August 18, 1922 (H. H. Knight); Carlton County, May 20, 1911; Cook County, Cascade River, August 14, 1922 (H. H. Knight); St. Louis County, Duluth; Clearwater County, Itasca Lake, June 27, 1911; Clearwater County, Itasca Park, August 15-30, 1921 (H. L. Person); Lake County, Kawishiwi River, August 30, 1919 (H. H. Knight); Roseau County, Clear River, June 29, 1920.

16. *Cicindela* var. *nebraskana* Casey

Blackish specimens without or almost without pattern.

Localities represented: Clearwater County, Itasca Lake, June 8, 1914; Crow Wing County, Nisswa, July 6, 1922 (Wm. E. Hoffmann).

17. *Cicindela fulgida* Say

This species is known to me from an unrecorded locality of the State of Minnesota.

18. *Cicindela scutellaris* subsp. *lecontei* Hald. = *modesta* Dejean 1825 (!)

Localities represented: Hennepin County; Ottertail County; Hennepin County, Fort Snelling, High Prairie, April 29, 1921 (R. N. Chapman).

19. *Cicindela sexguttata* Fabricius

Localities represented: Hennepin County, basswood-maple forest, July 21, 1922 (A. A. Nichol); Ramsey County; Ramsey County, St. Anthony Park, St. Paul, June 1, 1921 (H. H. Knight); Nicollet County, St. Peter, Fish Hatchery, July 22 (Wm. E. Hoffmann); Chisago County, Taylors Falls, June 23, 1920 (B. Kienholz).

20. *Cicindela sexguttata* subsp. *patruela* Dejean

The following Minnesota records were generously furnished by Professor Myron H. Swenk, Department of Entomology, University of Nebraska.

Localities represented: Crow Wing County, Pelican Lake, Nisswa, July 14, 20, 22, 23, 27, 28, and 30, 1912, and August 10 and 11, 1912 (L. Bruner).

21. *Cicindela punctulata* Olivier

Localities represented: Freeborn County, Albert Lea, July 10, 1923 (P. L. Keene); Anoka County, Fridley sand dunes, July 14, 1925 (C. E. Mickel); Hennepin County, July 6, 1910; Clearwater County, Itasca Park, August 4-30, 1921 (H. L. Person); Chisago County, North Branch, August 6, 1922 (Wm. E. Hoffmann); Scott County, dunes near Jordan, August 1, 1922 (Wm. E. Hoffmann); Hennepin County, Fort Snelling, August 27, 1924 (Allen McIntosh); Ramsey County, St. Anthony Park, St. Paul, August 1, 1920 and July 9, 1921 (H. H. Knight); Ramsey County, St. Paul, July 11, 1925, at light (Sam Kepperley).

22. *Cicindela pusilla* Say

Localities represented: Chisago County, July 16, 1911; Hennepin County; Ottertail County; Ramsey County; Red Lake County, August 1, 1923 (C. E. Mickel).

23. *Cicindela unipunctata* Fabricius

This species is known to me from an unrecorded locality of the State of Minnesota.

24. *Cicindela cuprascens* Leconte

This species is known to me from an unrecorded locality of the State of Minnesota.

25. *Cicindela cuprascens* subsp. *macra* Leconte

Localities represented: Scott County, Jordan sand area, July 13, 1923 (H. H. Knight); Ramsey County, Gray Cloud Island, July 12, 1921 (Wm. E. Hoffmann).

26. *Cicindela lepida* Dejean

Localities represented: Anoka County, Fridley sand dunes, August 3-8, 1924 (R. W. Dawson); Anoka County, Fridley sand dunes, July 14, 1922 (A. A. Nichol); Scott County, Jordan sand area, July 13, 1923 (H. H. Knight).

In addition to the species listed above there are two others: *Cicindela lengi* W. H. (= *venusta* Leconte) and *C. limbata* Say, which might occur in the state, altho there are no known records of these species from Minnesota.

Considering this group of species as a whole, there are three features of general interest: (1) All the forms belong to groups in which the four anterior trochanters bear so-called "fixed" hairs (W. Horn [3] in Wytsman's *Genera Insectorum,* Cicindelinae, 1908-15, p. 214). (2) If the Minnesota forms are compared with all of the Cicindelidae of the United States, or with those of the United States and Mexico, it will be noticed that all the Minnesota forms belong to groups in which the upper side of the head and pronotum bear bristles or hairs. I do not believe this is accidental, but think it may be a characteristic feature of the species found in northern localities. (3) The group of species represented here is a very restricted one, in my opinion, characteristic of northern regions.

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